

# CHAPTER 13

## Obesity

### KEY TEACHING POINTS

- Obesity increases the risk of diabetes, cardiovascular disease, and overall mortality.
- The best measures of obesity are body mass index (BMI) and waist circumference. Thresholds predicting increased mortality are BMI greater than  $25 \text{ kg/m}^2$  and waist circumference greater than 102 cm (>40 inches) in men and greater than 88 cm (>35 inches) in women.
- Abdominal obesity (elevated waist-to-hip ratio [WHR]) indicates a worse prognosis than gluteal-femoral obesity (reduced WHR).

### I. INTRODUCTION

Obesity increases the risk of coronary artery disease, diabetes, hypertension, osteoarthritis, cholelithiasis, certain cancers, and overall mortality.<sup>1</sup> Clinicians have recognized the hazards of obesity for thousands of years (according to one Hippocratic aphorism, “Sudden death is more common in those who are naturally fat than in the lean”).<sup>2</sup> Two-thirds of US adults are overweight or obese.<sup>3</sup>

### II. THE FINDINGS AND THEIR SIGNIFICANCE

Several different anthropometric parameters have been used to identify those patients at greatest risk for medical complications due to obesity. The most important ones are body mass index (BMI), skinfold thickness, waist-to-hip ratio (WHR), waist circumference, and abdominal sagittal diameter.

#### A. BODY MASS INDEX

##### 1. THE FINDING

BMI (or the Quetelet index) is the patient's weight in kilograms divided by the square of his height in meters ( $\text{kg/m}^2$ ). If pounds and inches are used, the quotient should be multiplied by 703.5 to convert the units to  $\text{kg/m}^2$ . An individual is overweight if BMI exceeds  $25 \text{ kg/m}^2$ , and obese if BMI exceeds  $30 \text{ kg/m}^2$ .<sup>3</sup>

BMI was derived by a 17th-century Belgian mathematician and astronomer, Lambert-Adolphe-Jacques Quetelet, who discovered that this ratio best expressed the natural relationship between weight and height.<sup>4</sup>

##### 2. CLINICAL SIGNIFICANCE

BMI is an easy and reliable measurement that correlates well with precise measures of total body fat ( $r = 0.70$  to  $0.96$ ), much better than other formulas of weight ( $W$ ) and height ( $H$ ) (e.g.,  $W/H$ ,  $W/H^3$ ,  $W/H^{0.3}$ ).<sup>5,6</sup> BMI also correlates significantly with a patient's cholesterol level, blood pressure, incidence of coronary events, and overall mortality.<sup>7,8</sup>

The arbitrary cutoff of 25 kg/m<sup>2</sup> was chosen in part because it reflects the level at which there is a significant increase in mortality. Many studies of BMI and mortality revealed a J-shaped relationship (i.e., both lean and overweight patients have increased mortality), but the increased risk of lean individuals is likely explained by cigarette use, short duration of follow-up, and illness-related weight loss.<sup>7,8</sup>

## B. SKINFOLD THICKNESS

Another measure of obesity is *total skinfold thickness*, which is estimated by adding together the skinfold thickness (measured with calipers) of multiple sites (mid-biceps, mid-triceps, subscapular, and supra-iliac area). These sums are then converted by formulas into estimates of total body fat, which correlate well with more traditional measures ( $r = 0.7$  to  $0.8$ ).<sup>5</sup> Measurements of skinfold thickness are rarely used today, in part because of their complexity, but mostly because relatively few studies show the parameter to be clinically significant.

## C. WAIST-TO-HIP RATIO

### 1. THE FINDING

WHR is the circumference of the waist divided by that of the hips. It is based on the premise that the most important characteristic of obesity is its distribution, not its quantity. Abdominal obesity (also called android, upper body, or apple-shaped obesity; Fig. 13.1) has a much worse prognosis than gluteal-femoral obesity (also called gynoid, lower body, or pear-shaped obesity).

Most authorities measure the waist circumference at the midpoint between the lower costal margin and the iliac crest and the hip circumference at the widest part of the gluteal region. Adverse health outcomes increase significantly when WHR exceeds 1 in men and 0.85 in women, values that are close to the top quintiles in epidemiological studies.<sup>9</sup>

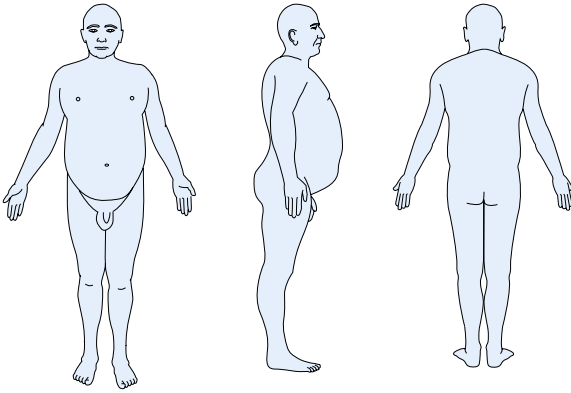
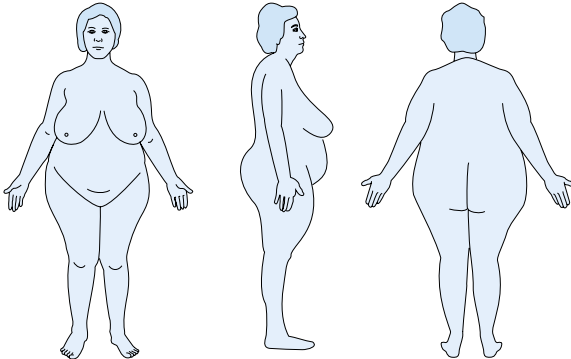
The French diabetologist Jean Vague is usually credited with making the observation in the 1940s that abdominal obesity, more common in men, is associated with worse health outcomes than obesity over the hips and thighs, more common in women (even so, American life insurance companies made the same observation in the late 1800s).<sup>10</sup> Vague's original *index of masculine differentiation*, a complicated index based on skinfolds and limb circumferences,<sup>11</sup> is no longer used, having been replaced by the much simpler WHR in the 1980s.

### 2. CLINICAL SIGNIFICANCE

Even after controlling for the effects of BMI, WHR correlates significantly with blood pressure, cholesterol level, incidence of diabetes mellitus, stroke, coronary events, and overall mortality.<sup>12,13</sup>

### 3. PATHOGENESIS

The main contributor to abdominal obesity is visceral fat (i.e., omental, mesenteric, and retroperitoneal fat), not subcutaneous fat. Visceral fat is metabolically active, constantly releasing free fatty acids into the portal circulation, which probably contributes to hyperlipidemia, atherogenesis, and hyperinsulinemia.<sup>14</sup> Gluteal-femoral fat, on the other hand, is metabolically inactive except during pregnancy and the postpartum period, which has led some to suggest that the role of lower body fat is to help guarantee the survival of the species by providing a constant source of energy to the lactating female even when external nutrients are unavailable.

**Abdominal obesity****Gluteal-femoral obesity**

**FIG. 13.1 COMPARISON OF ABDOMINAL AND GLUTEAL-FEMORAL OBESITY.** Abdominal obesity is depicted in the top row; gluteal-femoral obesity in the bottom row. The drawings in this figure are adapted from photographs published by Vague,<sup>11</sup> who is credited with first associating adverse health outcomes with abdominal obesity.

**D. WAIST CIRCUMFERENCE**

Waist circumference is simply the numerator of WHR calculation. It has the advantages of being simpler to measure and avoiding any consideration of the hips, which, because they encompass bone and skeletal muscle as well as fat, should have no biologically plausible relationship to diabetes, hypertension, and atherosclerosis. Recommended cutoffs for increased health risk are a waist circumference >102 cm (>40 inches) for men and >88 cm (>35 inches) for women.<sup>15</sup>

Waist circumference is strongly associated with risk of death, independent of BMI.<sup>13,16</sup> Waist circumference is also a criterion for the **metabolic syndrome** (defined as the presence of three or more of the following five variables: large waist circumference, hypertension, elevated triglycerides, reduced HDL cholesterol, and elevated fasting glucose).<sup>17</sup>

## E. SAGITTAL DIAMETER

Because waist circumference encompasses both subcutaneous and visceral fat, investigators have looked for better anthropometric measures of just visceral fat. One proposed measure is the sagittal diameter, which is the total anterior-posterior distance between the anterior abdominal wall of the *supine* patient and the surface of the examining table. Theoretically, visceral fat maintains the abdominal depth in the supine patient, whereas subcutaneous fat allows the abdominal depth to partially collapse from the force of gravity.<sup>18</sup> Even so, there are few studies of this measure, and most correlate it with variables of uncertain clinical significance, such as cardiovascular risk factors or the amount of visceral fat indicated by body imaging.<sup>14</sup>

*The references for this chapter can be found on [www.expertconsult.com](http://www.expertconsult.com).*

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